

ICARUS Data Quality

ICARUS Collaboration Meeting
October 15th, 2024

Harry Hausner – Fermilab

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MAGING

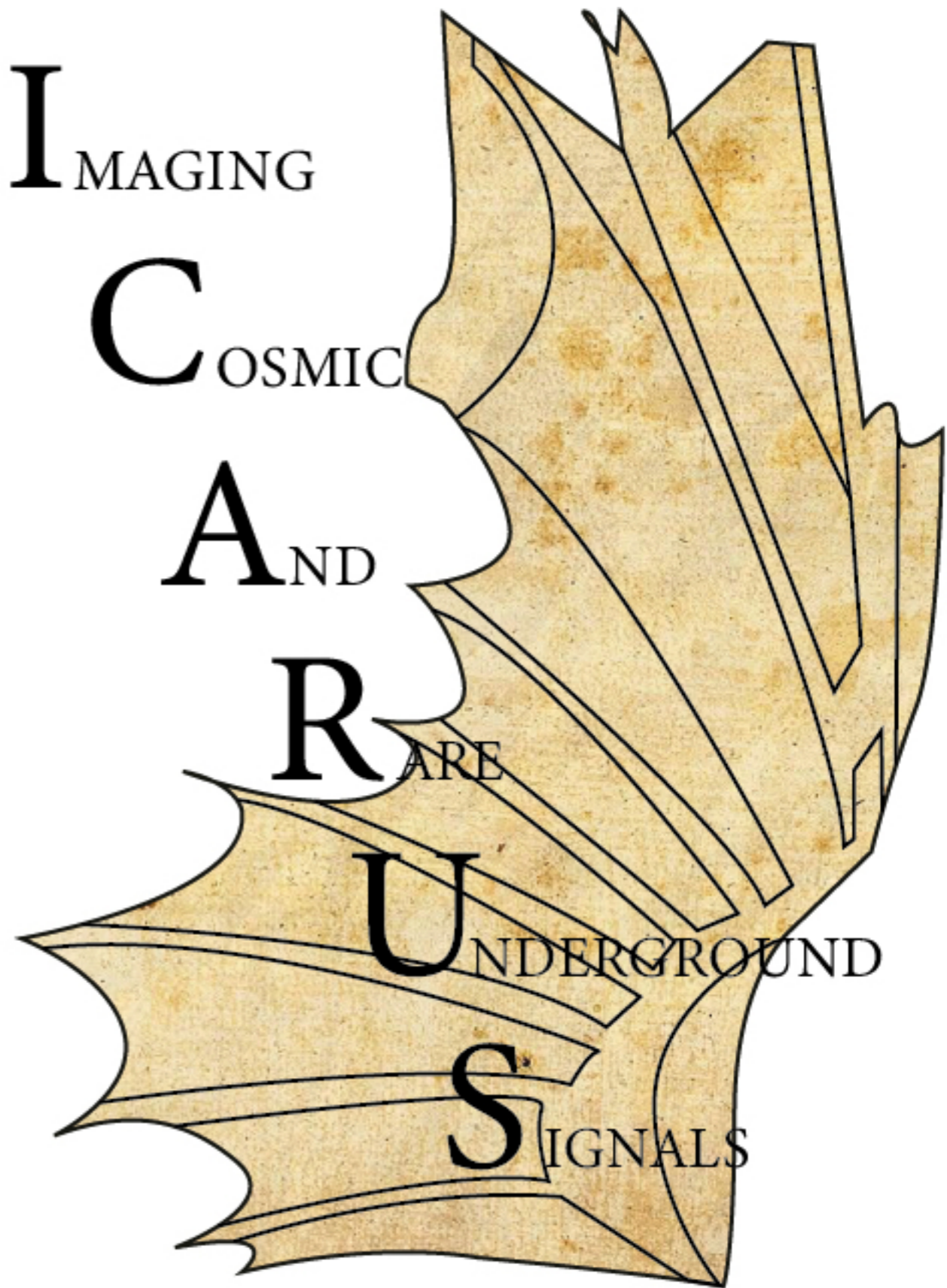
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Data Quality

Current Implementations

- Two main checks on data quality (DQ)
- Offline checking run-by-run stability metrics
 - These look at different quantities averaged over an entire run (ie stable detector configurations) and looks for outliers
 - These metrics are mostly focused on noise in events, but also includes a check on “beam-like” events
- CI validation checks
 - Histograms for different qualities are generate for each run
 - Computes χ^2 with reference run

Run Stability

Metrics

- We have three primary metrics for run stability developed for the Dimuon analysis
 - **Average number of slices per event**
 - If an event has more slices than usual this can be due to noise
 - **Average number of PFPs per event**
 - If an event has more PFPs than usual this can be due to noise which looks like physics
 - **Average number of “beam-like” slices per event**
 - Slice is not a Clear Cosmic according to PANDORA, and the longest track has a γ -direction cosine between ± 0.1
 - These average is background subtracted by removing the expected number of “beam-like” slices seen in the off-beam stream
- These metrics are calculated only for runs with more than 100 events and runs are considered “good” if they fall within 3σ of the mean value for all runs considered

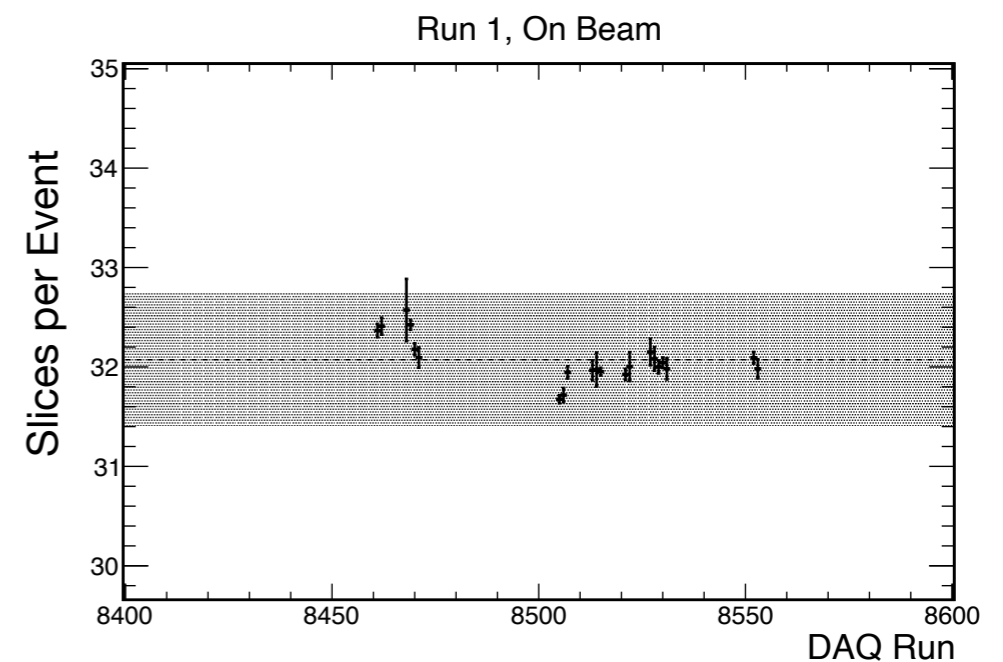
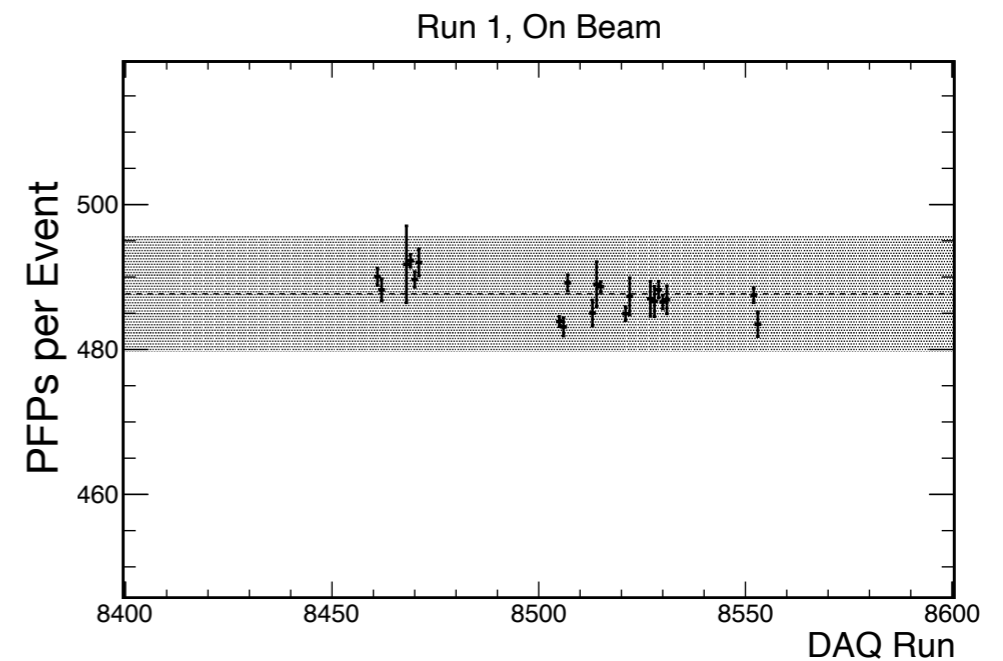
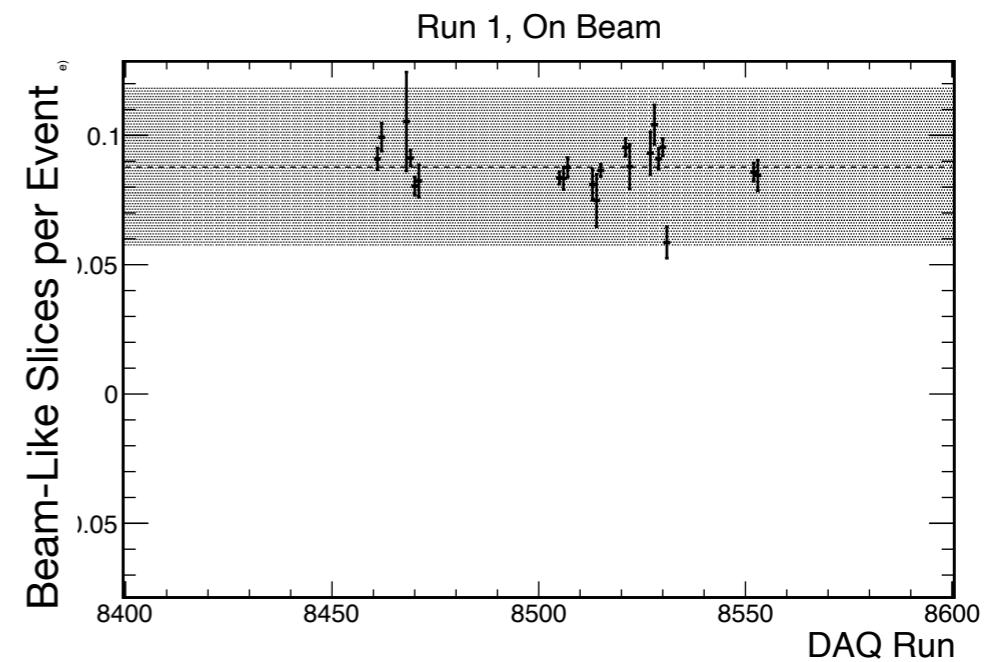
Run Stability

Run 1 (NuMI from Dimuon)

- Run 1 NuMI runs were looked at as part of the [Dimuon analysis](#)
- All Run 1 DAQ runs considered were considered good

DAQ Run Number						
8460	8461	8462	8468	8469	8470	8471
8505	8506	8507	8513	8514	8515	8517
8518	8521	8522	8525	8527	8528	8529
8530	8531	8552	8553			

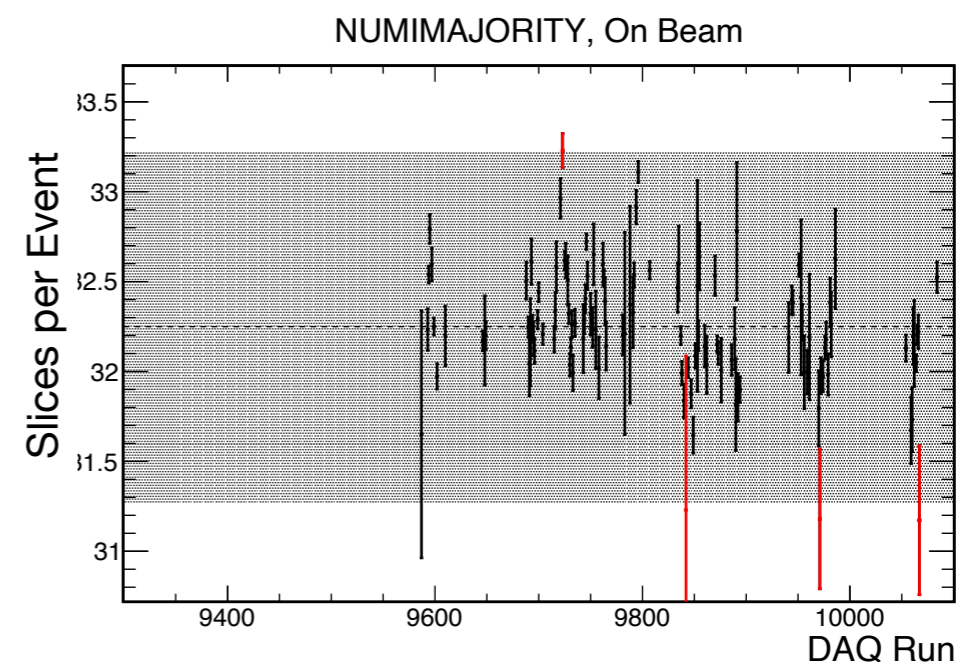
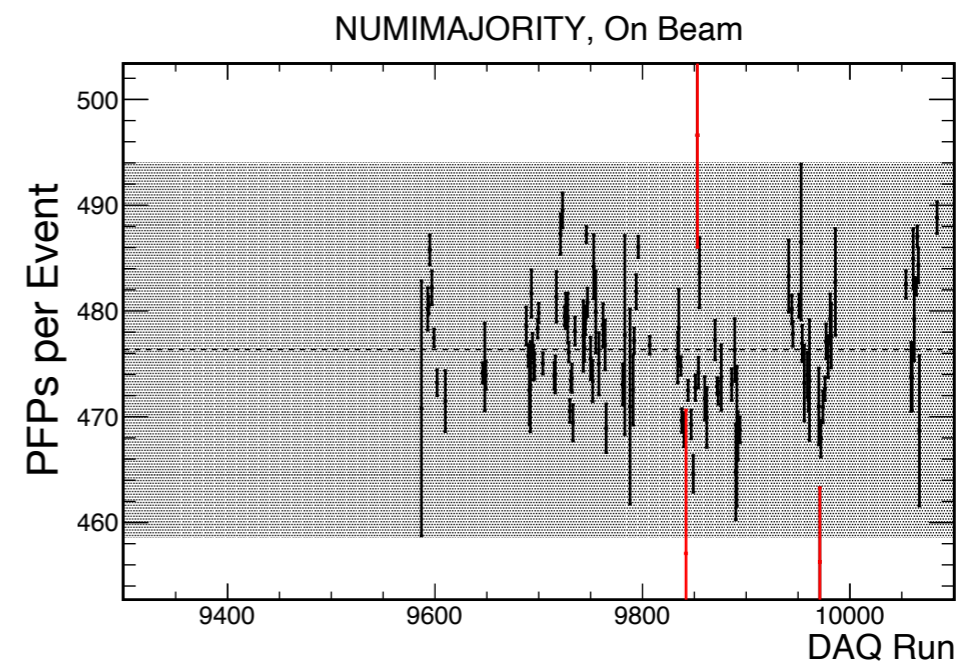
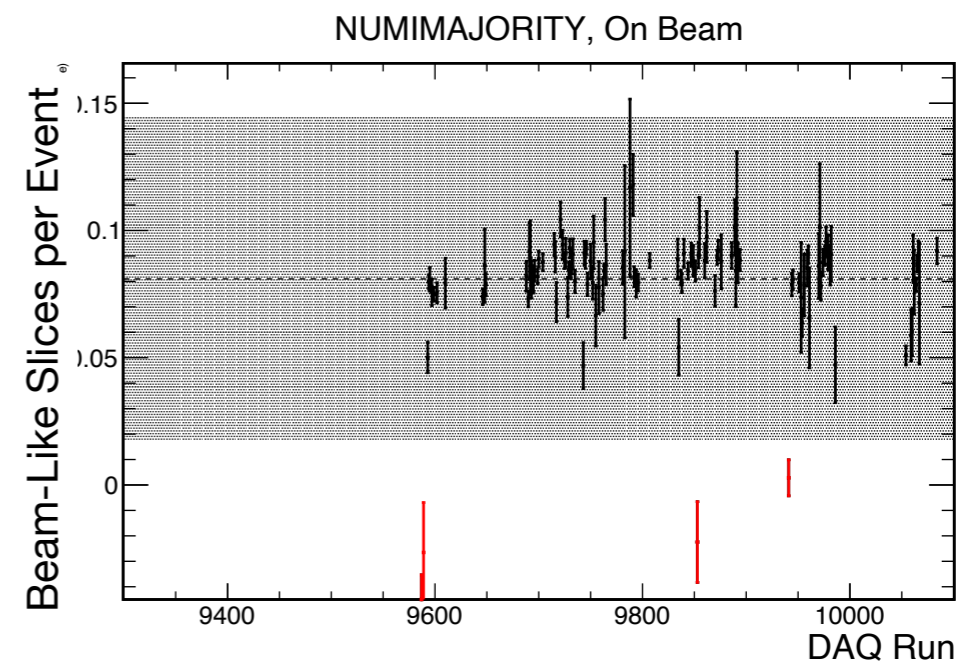
Table 3: Good for physics DAQ runs from ICARUS Run 1.



Run Stability

Run 2 (NuMI)

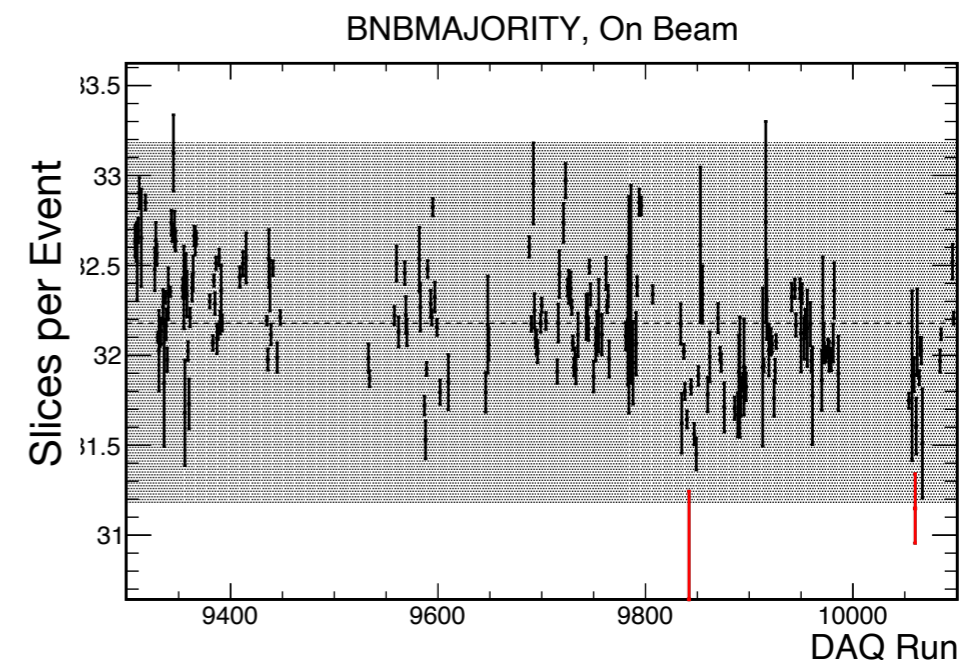
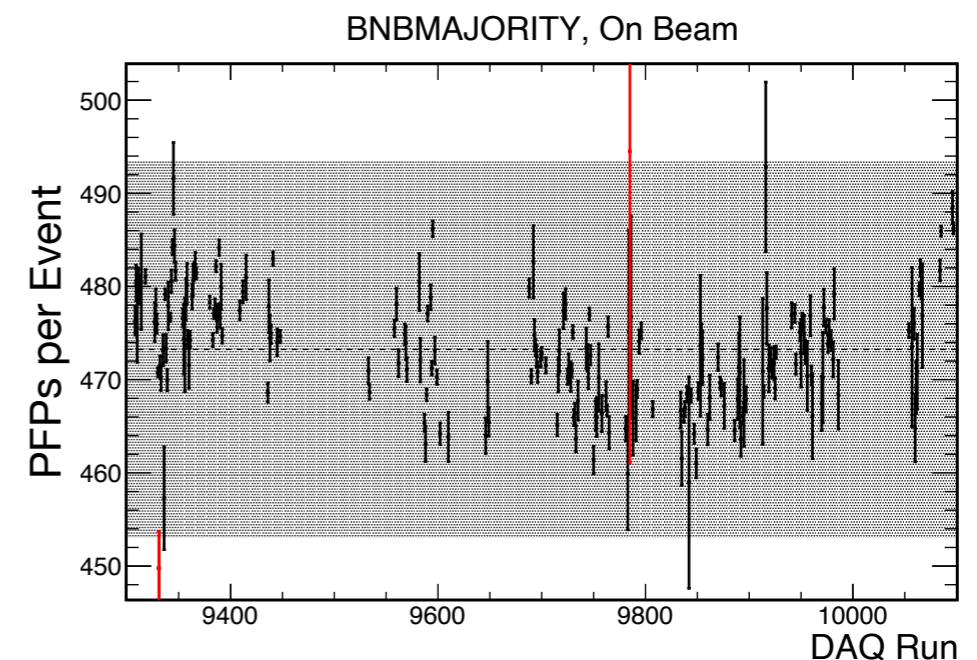
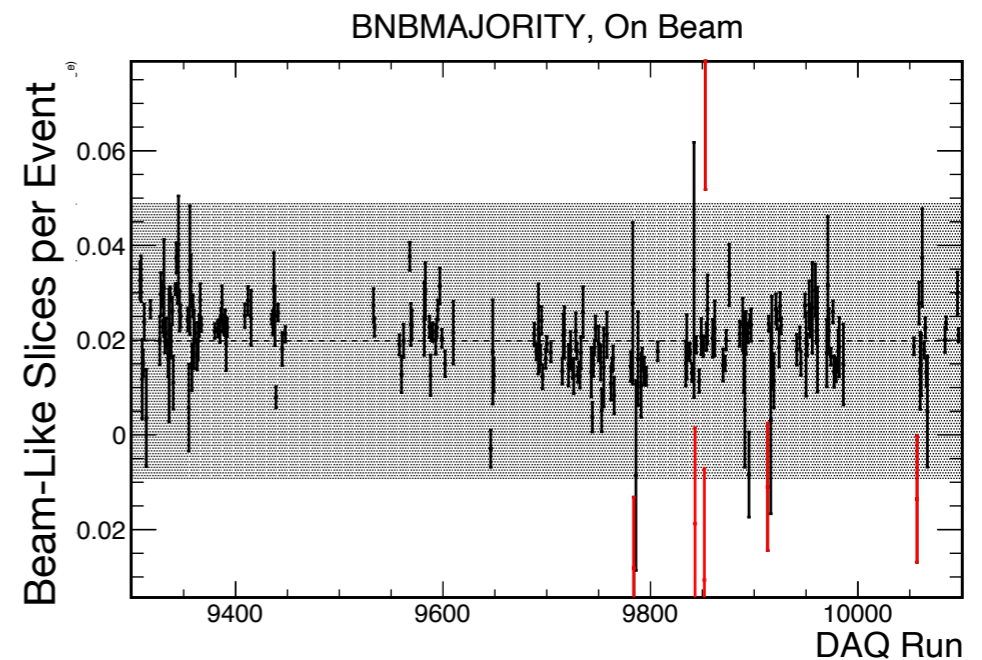
- In Run 2 we see some runs which fail our consistency metrics
- Flagged “bad” runs are 9587, 9589, 9723, 9727, 9784, 9785, 9842, 9843, 9852, 9853, 9941, 9971, & 10067
- Details for each run in backup



Run Stability

Run 2 (BNB)

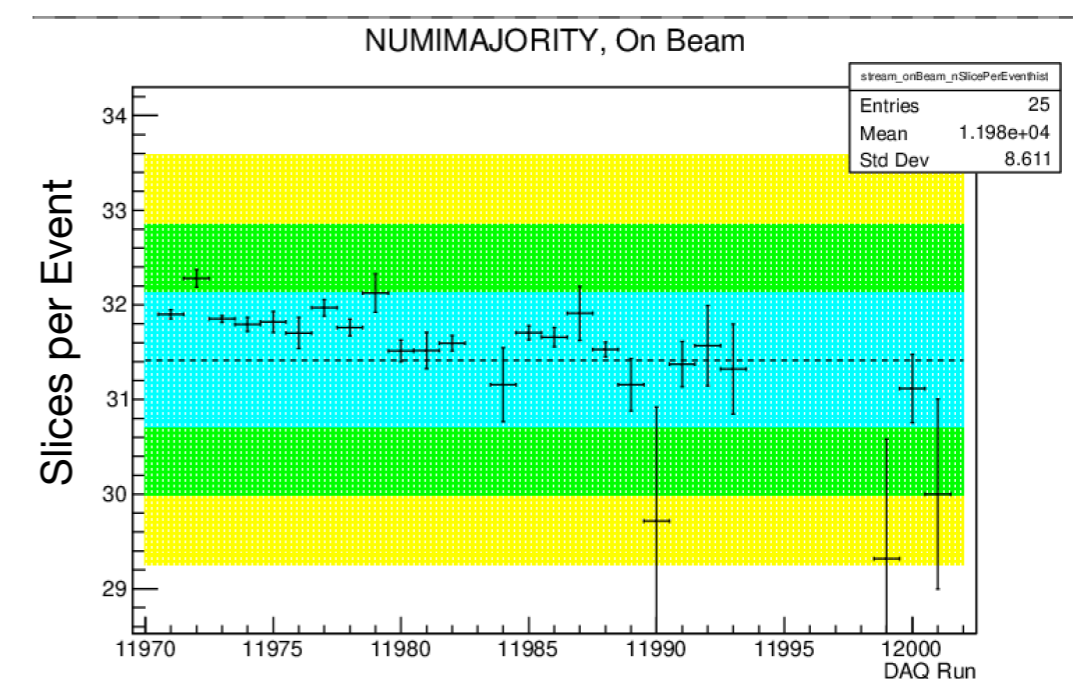
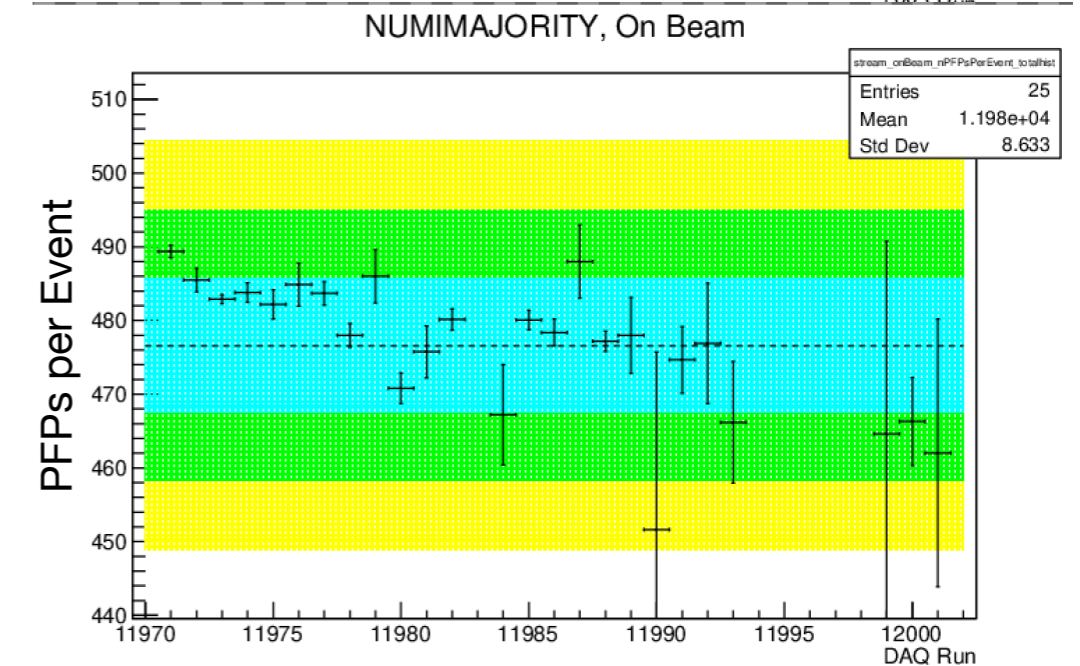
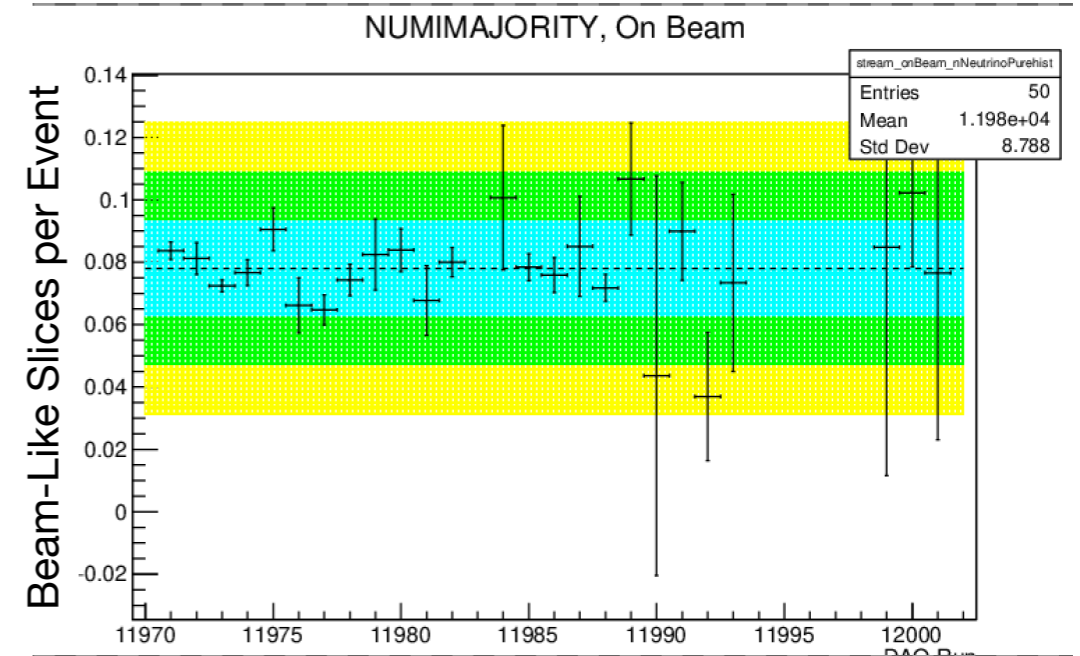
- In Run 2 we see some runs which fail our consistency metrics
- Flagged “bad” runs are 9331, 9727, 9782, 9784, 9785, 9842, 9843, 9852, 9853, 9913, 10057, & 10060
- Details for each run in backup



Run Stability

Run 3 (NuMI)

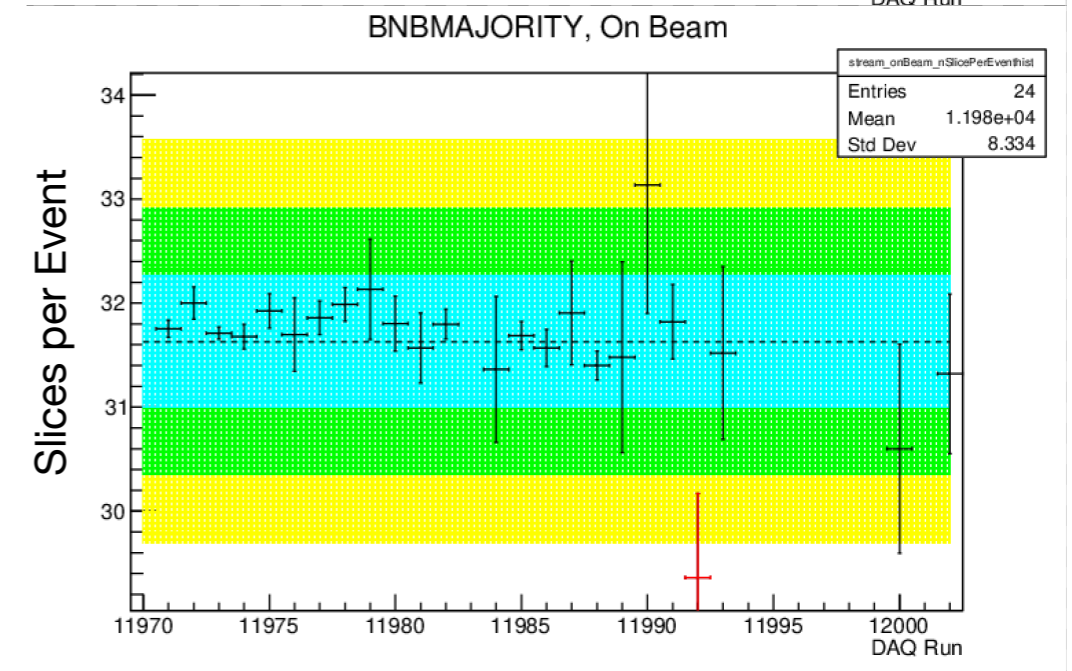
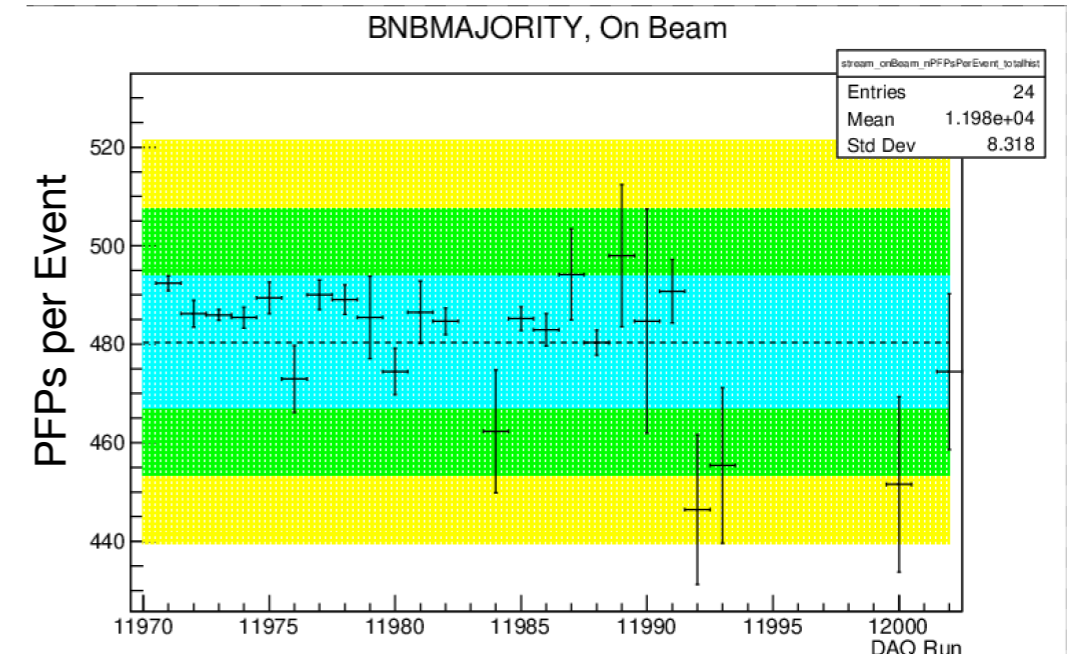
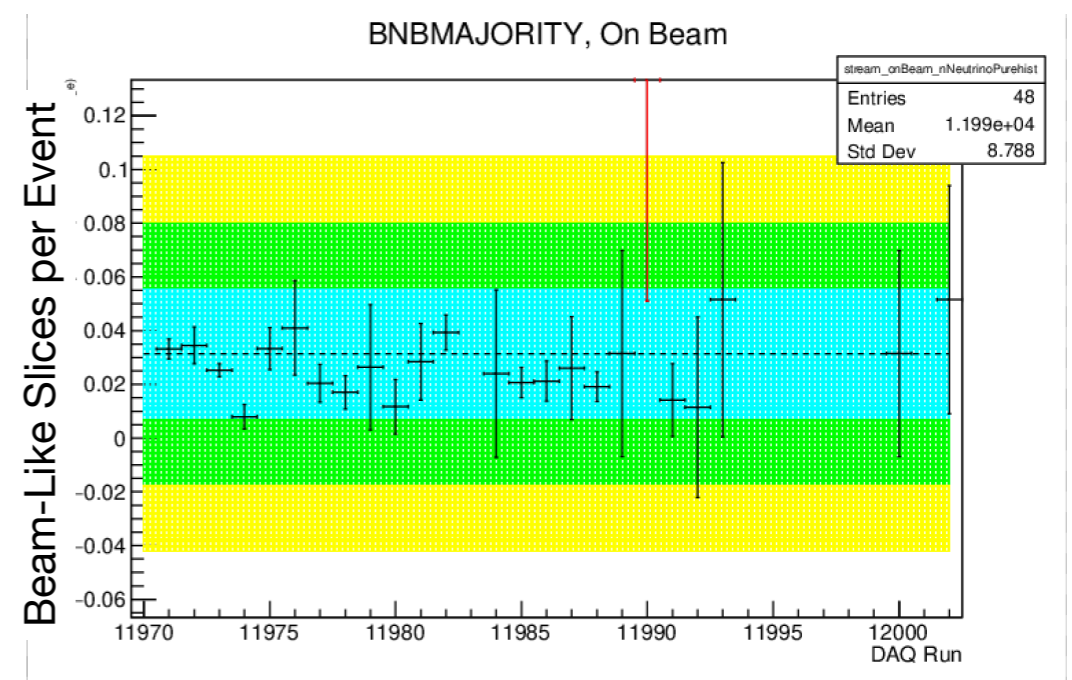
- Run 3 investigated by Alex Lehan
- Run 3 NuMI looks consistent so far



Run Stability

Run 3 (BNB)

- Run 3 investigated by Alex Lehan
- Run 11990 has an excess number of “beam-like” slices per event compared to the average
- Run 11992 shows fewer slices per event than the average



Data Quality for Run 3

Alex Lehan/Minerba Betancourt

- The continuous integration (CI) framework was used to study the data quality of Run 3, more details at SBN-doc-37253
- Several metrics were evaluated for each system TPC, PMT and CRT
 - Reconstructed X,Y and Z positions, ADC, ADC/cm, times and others
- Data from Run 3 looks great!

ICARUS DQM v09_82_02_01

Build	Start Time	Build Type	mergeana	validation
icarus_ci_test/409 (ICARUS)	2024-07-08 09:33:05.080329	slf7 e26:prof	✓	✓

Progress Legend

- Successful
- Failed
- Pending
- Warning
- Skipped
- Held
- Unknown

Phase: ci_validation_lite

ci_validation_liteICARUS.log

Ana_East_CalibrationCompare/
Ana_West_CalibrationCompare/
CRT_CalibrationCompare/
East_CalibrationCompare/
West_CalibrationCompare/
Started: 07/08/2024 08:50:34
Finished: 07/08/2024 09:33:07. Exit code: 0

+ Ana_East_Calibration/
+ Ana_East_CalibrationCompare/
+ Ana_West_Calibration/
+ Ana_West_CalibrationCompare/
+ CRT_Calibration/
+ CRT_CalibrationCompare/
+ East_Calibration/
+ East_CalibrationCompare/
+ West_Calibration/
+ West_CalibrationCompare/

Individual run compared to a reference run

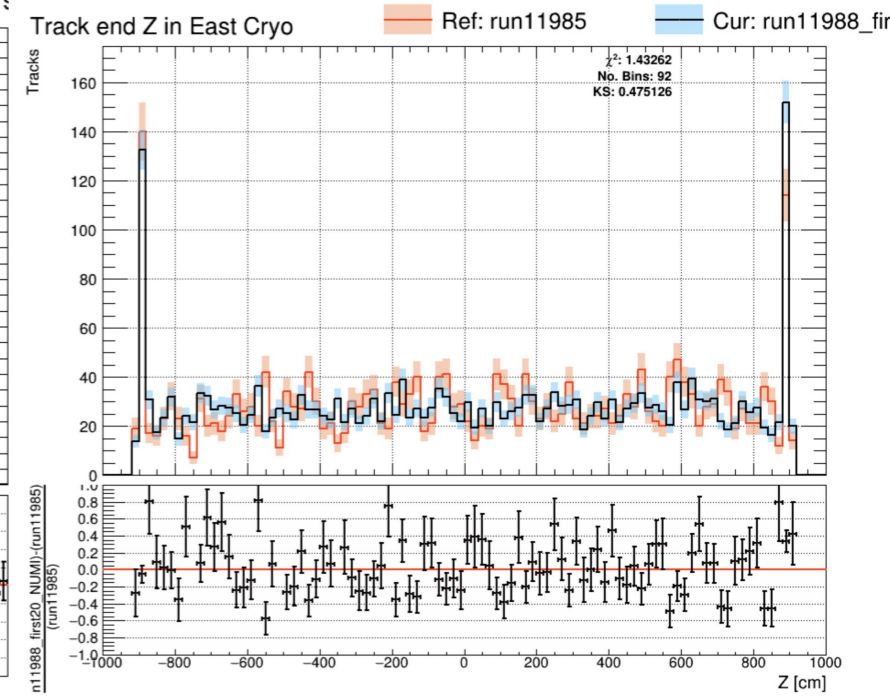
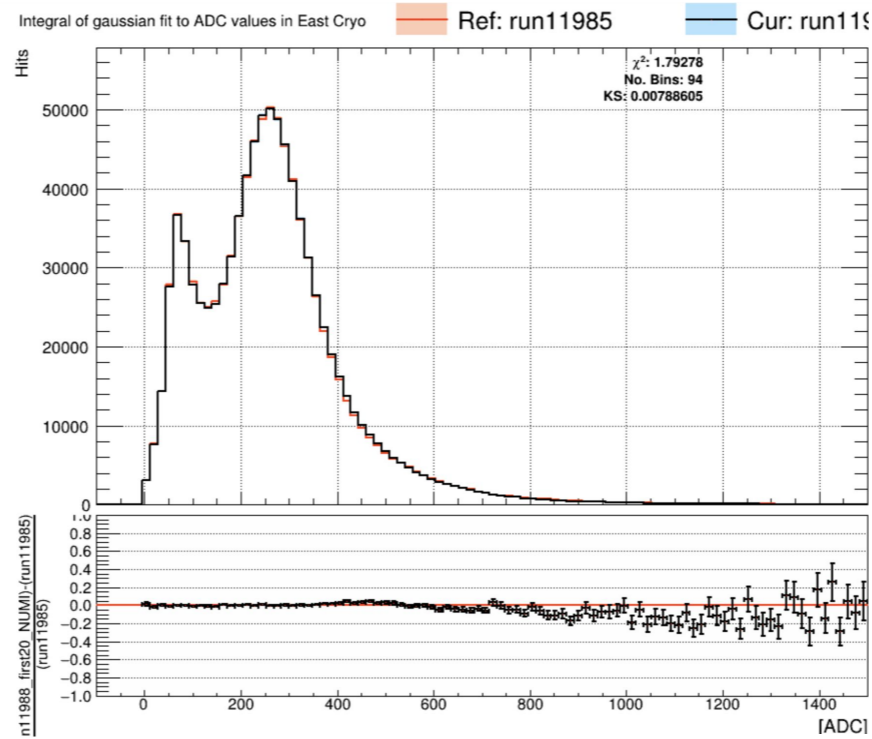
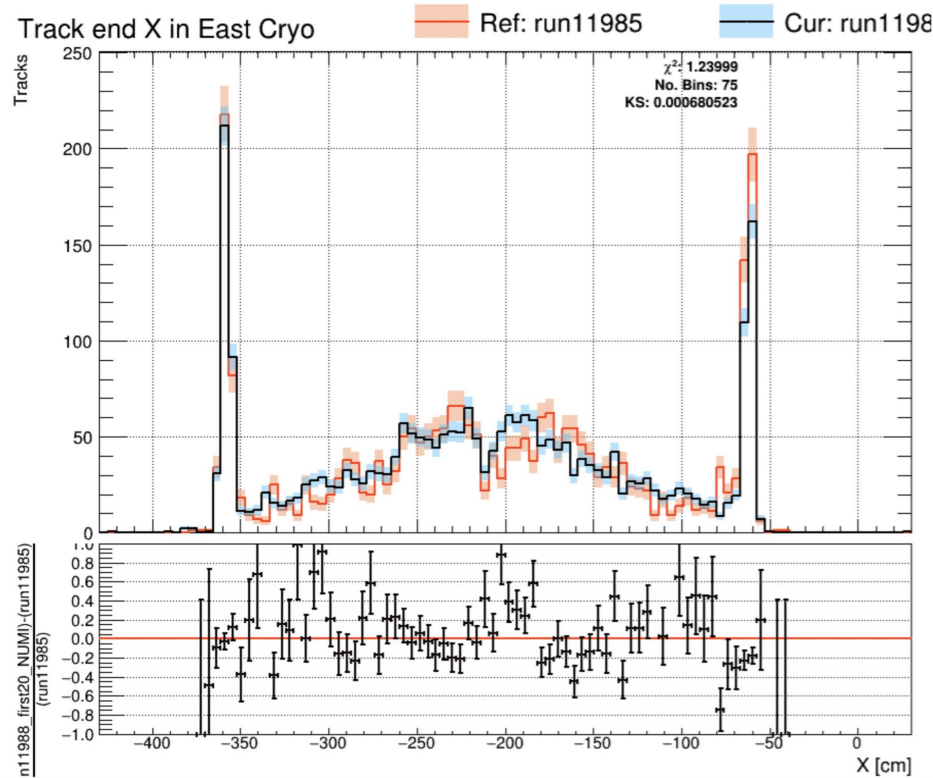
Folders with validation plots expanded

Information for TPC, PMT, east and west cryos, and CRT

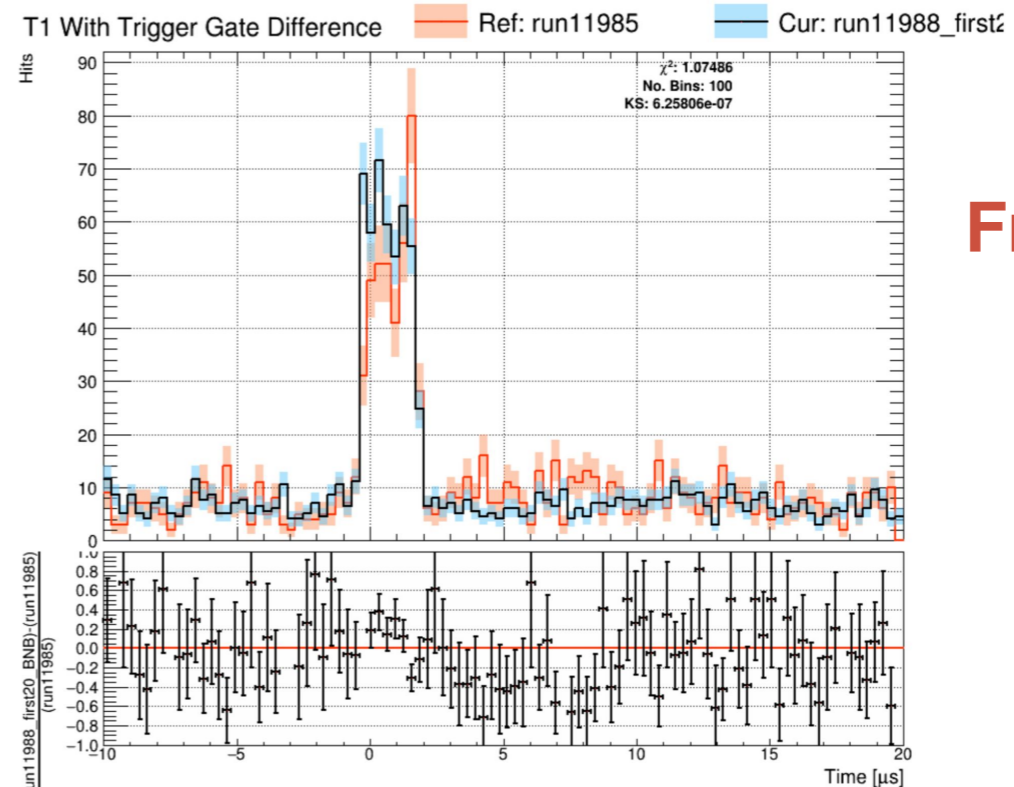
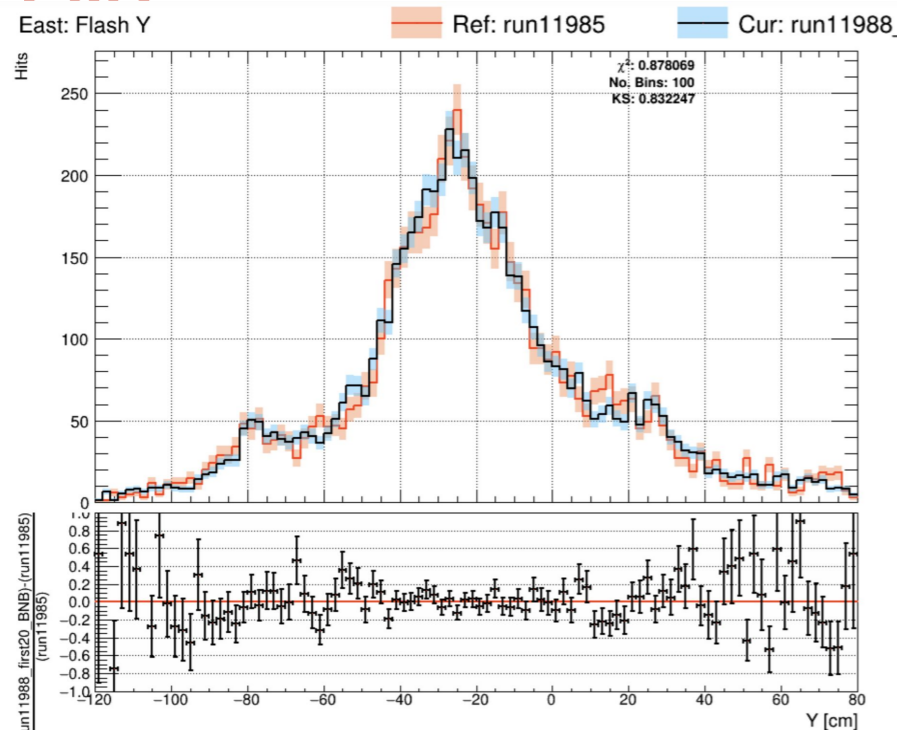
[Link to the CI Validation Dashboard](#)

- Metrics for each run are available here: <https://docs.google.com/spreadsheets/d/15PPTJpnylGNFKUqa9FwSQv9tMy7n0H50GZSwgFE34lo/edit?gid=0#gid=0>

From TPC



From PMT

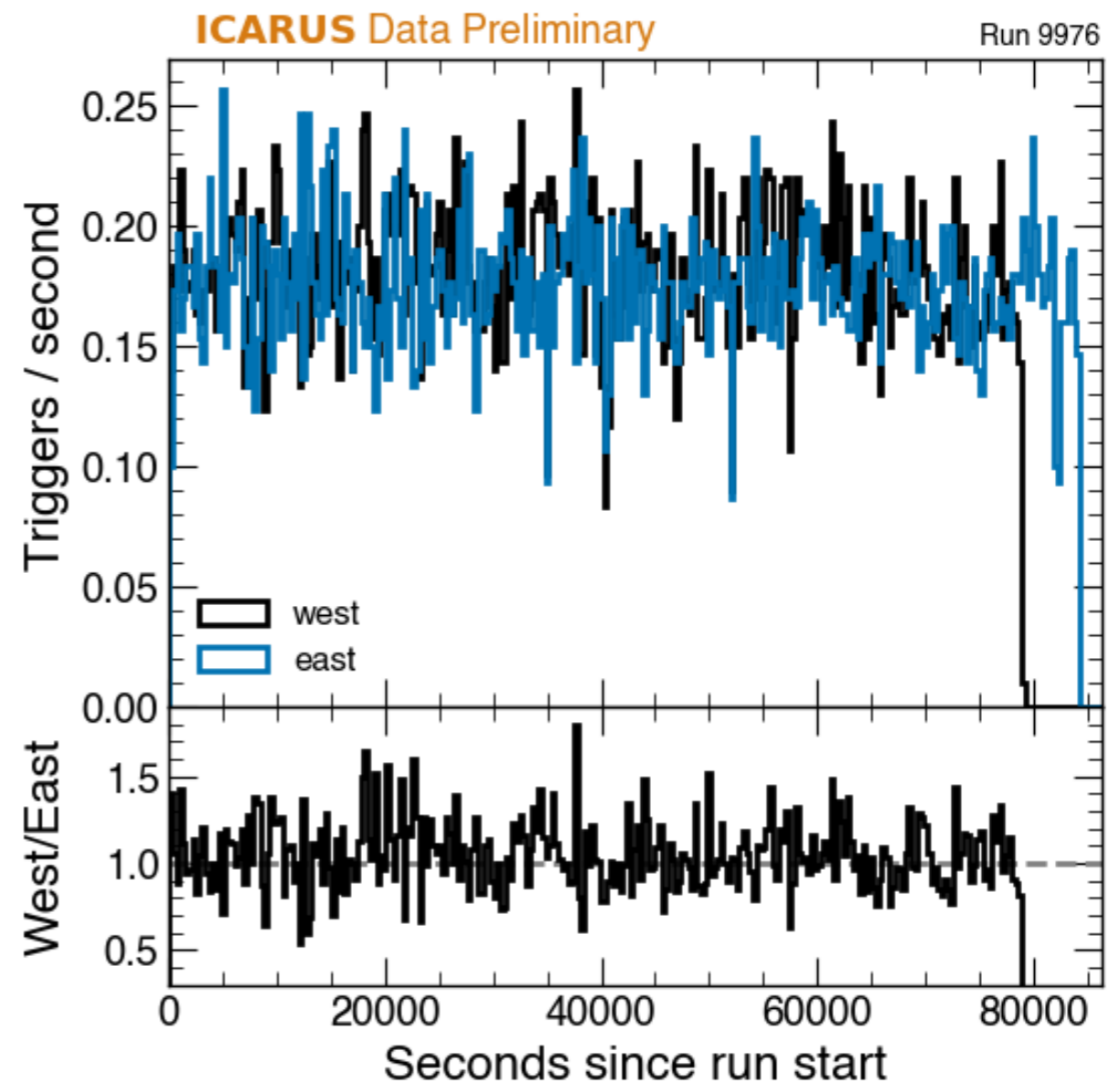


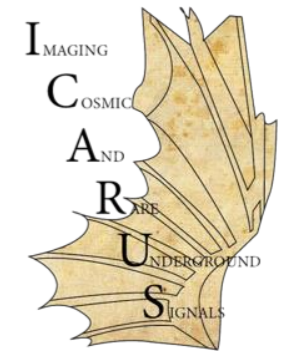
From CRT

Looking Towards The Future

Trigger Database

- The above metrics look at DAQ runs as a whole
- This neglects issues which can occur at the end of a run only
- Consider run 9976, which failed our scan of “good” runs due to a West PMT HV failure at the end of the run
- Using Justin Mueller’s trigger database we can pinpoint when the failure occurred, allowing us to potentially recover the rest of the run
- To integrate the database into a quality filter would take some effort, and work is needed to get the database working with Run 3 data





BNB Quality Studies

Jacob Smith

[ICARUS Collaboration Meeting](#)

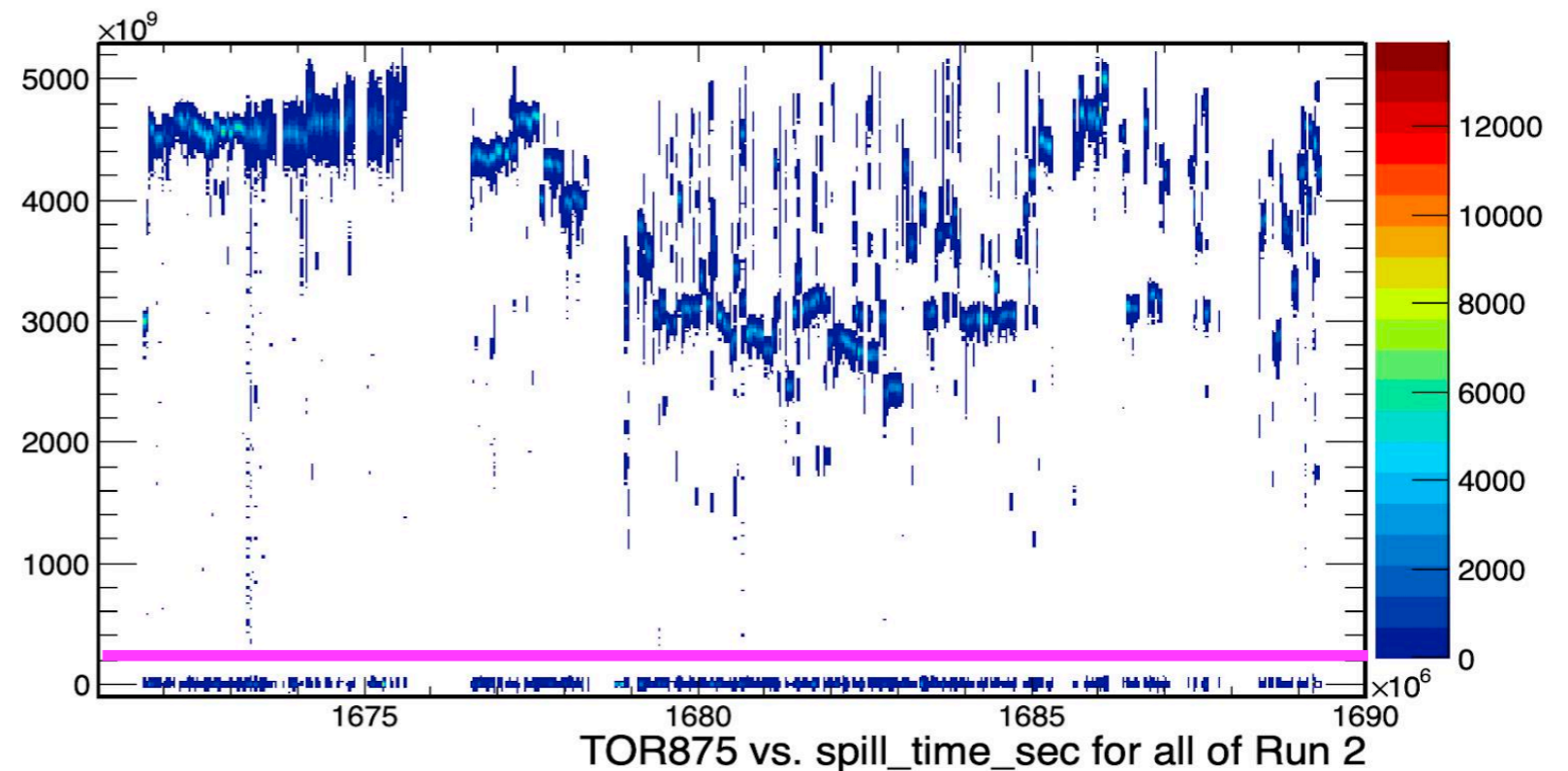
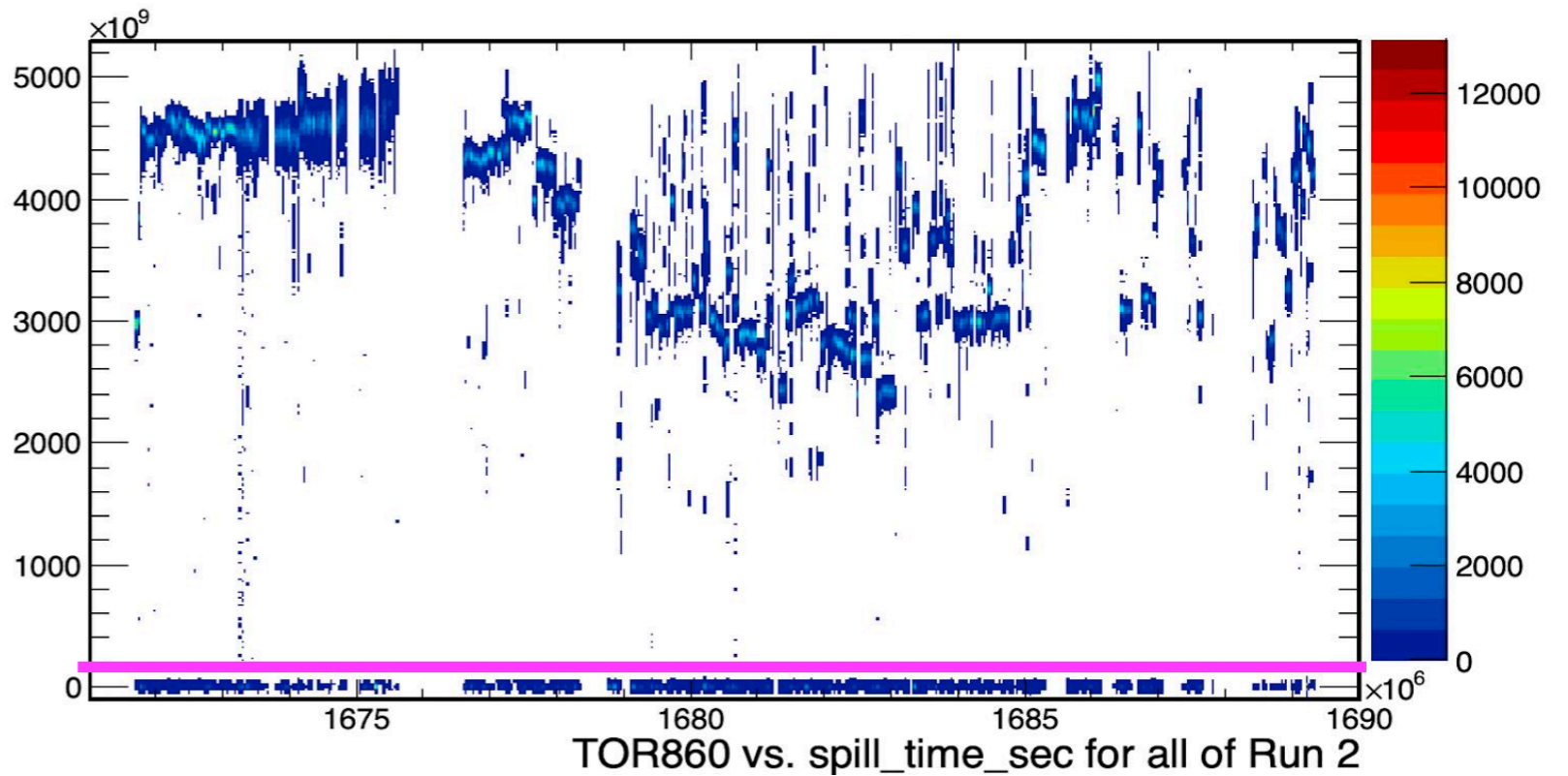
[October 2024](#)

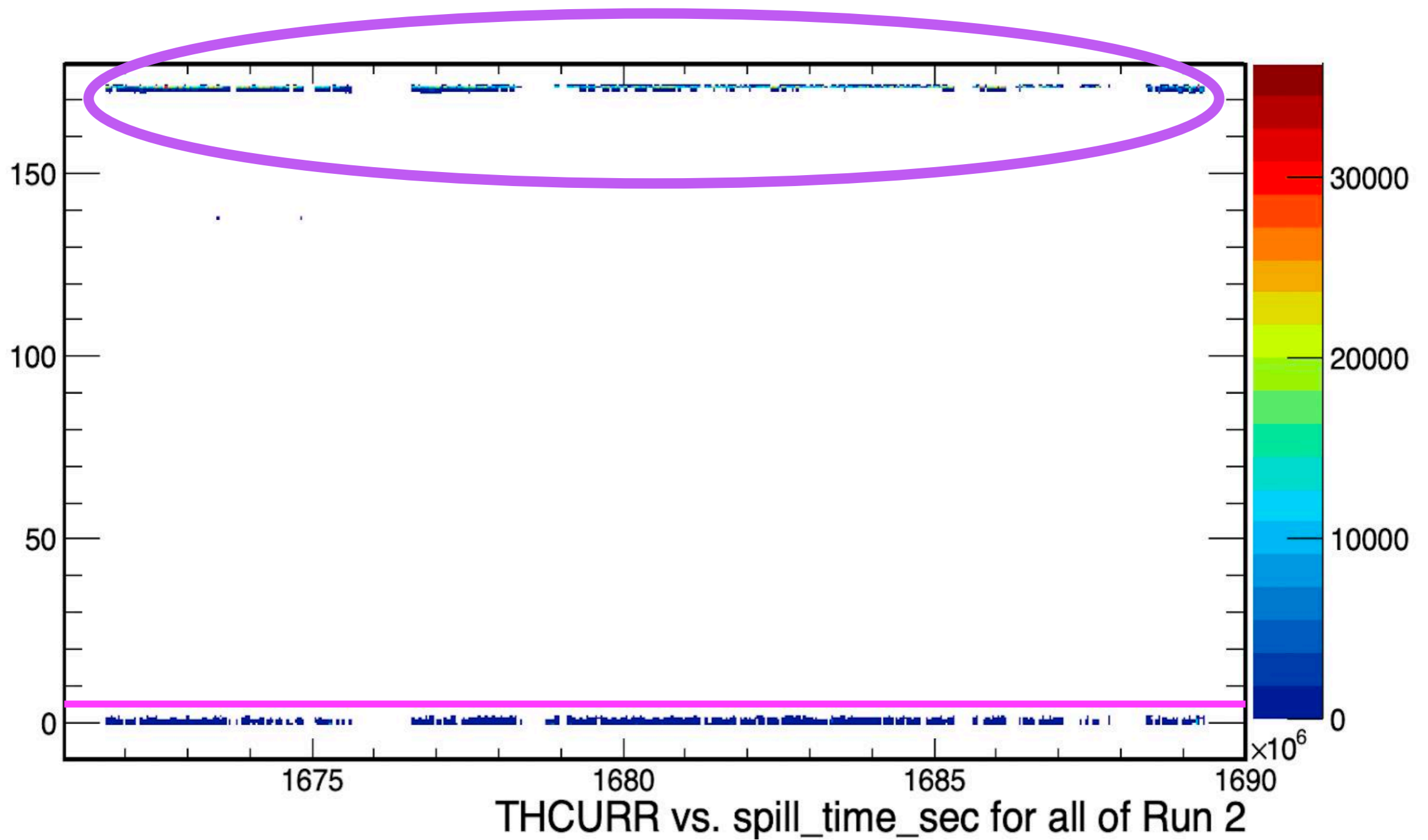
Variable Overview

- All spills (triggered and un-triggered) for Run 2
- Data lives on persistent: jzettle/cafs_eventsel/run2_prescaled_*.flat.caf.root
- POT scaling not yet applied (immediate next step)
- Preliminary cuts shown in **pink** on subsequent slides; to be refined later
- No selection applied; effects may differ on selected neutrino events

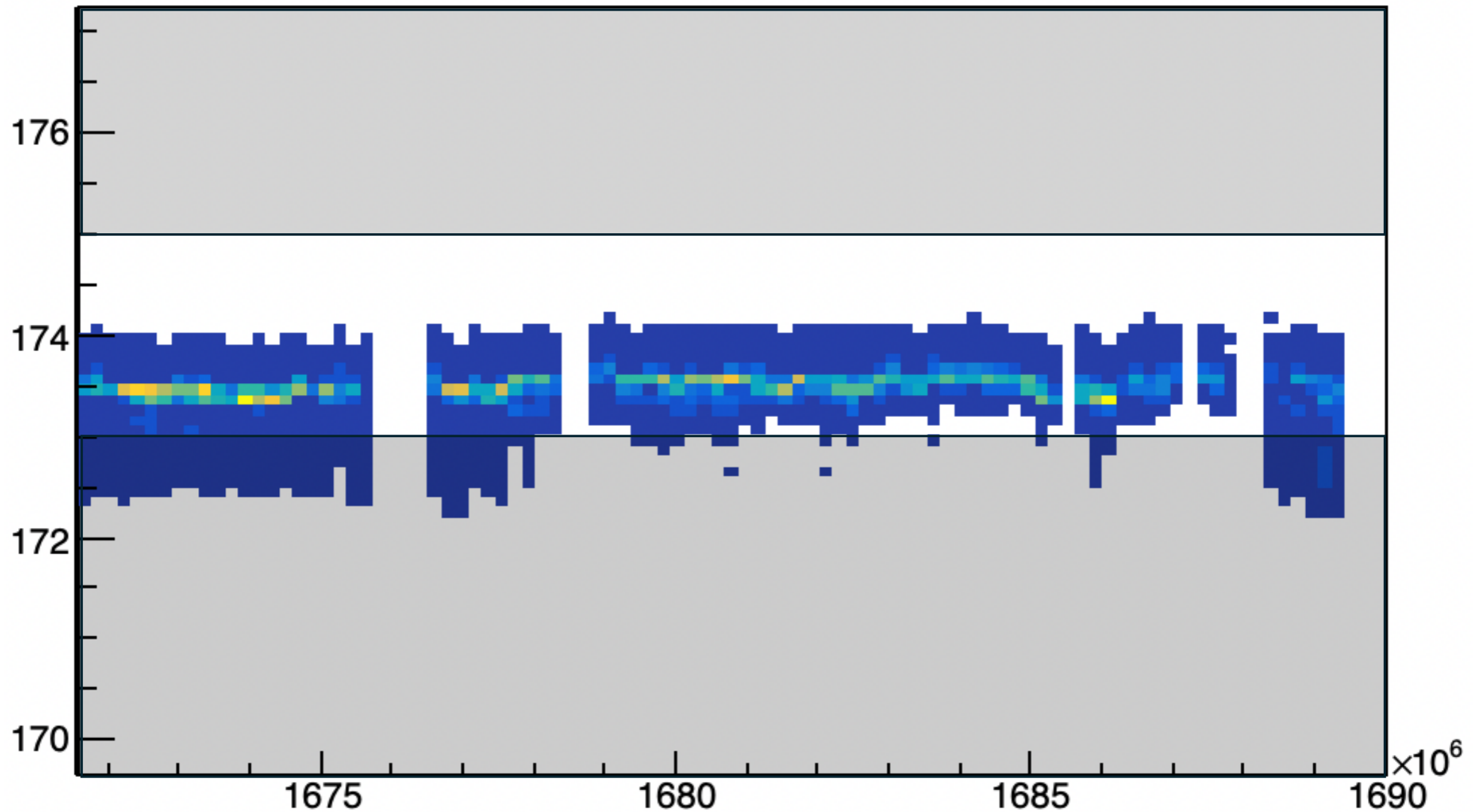
```
104 TOR860;
105 TOR875; //!< Value used for POT accounting
106
107 LM875A; //!< Loss Monitor before the RWM, unit R/s
108 LM875B; //!< Loss Monitor after the RWM, unit R/s
109 LM875C; //!< Loss Monitor after the RWM, unit R/s
110 HP875; //!< Horizontal Position Monitor after Mag 875, units mm
111 VP875; //!< Vertical Position Monitor after Mag 875, units mm
112
113 HPTG1; //!< Horizontal Position Monitor at Target Station 1, units mm
114 VPTG1; //!< Vertical Position Monitor at Target Station 1, units mm
115
116 HPTG2; //!< Horizontal Position Monitor at Target Station 2, closest to target, units mm
117 VPTG2; //!< Vertical Position Monitor at Target Station 2, closest to target, units mm
118
119 BTJT2; //!< Temperature of air exiting target, units Deg C
120
121 THCURR; //!< Current applied to Horn, units kiloAmperes
```

- TOR variables monitor POT received
- Higher number → closer to target (more reliable); keep TOR860 as backup
- **Cut near-zero entries, i.e. keep entries above 100E9**
- Variations understood; ~4500e+09 POT when just BNB operating, ~3000e+09 POT when NuMI also operating





Cut near-zero entries, i.e. keep entries above 3 kA



THCURRE vs. spill_time_sec for all of Run 2

Final (?) cut ± 1 kA around nominal 174 kA

Summary

Variable (vs. spill_time_sec)	Remaining Entries	Percentage <u>Before</u> Preliminary Cut	Percentage <u>After</u> Preliminary Cut
<u>PRELIMINARY</u> (i.e. near-zero)			
TOR860	4.558e+06	94.2687 %	
TOR875	4.598e+06	95.0893 %	
THCURR	4.59825e+06	95.0911 %	
<u>ROUGH CUTS</u>			
THCURR	4.430e+06	91.6137 %	96.3431 %

- Cuts made on TOR860, TOR875 (preferred), and THCURR

Next Steps

- POT scaling
- Create figure of merit to cut on all beam quality devices (see Variable Overview)
 - Similar to what MicroBooNE did with [their FOM2](#)
- Account for BNB incident direction on the target
 - FOM2 doesn't seem to do this

Data Quality Conclusions

- Things look good so far, but there is always more work to be done
- We have opportunities for folks to get involved on projects they can put their name on
- Join us in [#icarus-data-quality-requirements](#) on Slack!

Backup

Run 2 NuMI

Cut Runs

Run	Cut	Duration		My Comments
9587	Beam-like	28:42:00	"Stopped to test new pedestals"	Before run there was a blown fuse in TPCPSEE17, next run had a PMT server crash
9589	Events, Beam-like	55:58:00	"(~109k) DAQ interface closed accidentally"	
9723	Slices	11:45:00	"Beam down swith to Calibration"	
9727	Events	0:02:00	"this run was started w.o. "wr" by mistake and immediately stopped."	
9784	Events	0:13:00	N/A	DAQ/Trigger tests, labeled "good for physics"
9785	Events	0:04:00	N/A	DAQ/Trigger tests, labeled "good for physics"
9842	Events, Slices, PFPs	0:10:00	"CRT replaced. back in"	Just above run there is the note "Starting from now Top CRTs with mac5 165 and 212 need to be recalibrated since the FEB were replaced."
9843	Events	0:08:00	N/A	Just above run is the note "DAQ new release test (thses runs should be good for physics)"
9852	Events	0:03:00	"DAQ quick test to test new DAQInterface version, still issues with log messages"	DAQ testing, but not listed what was tested
9853	PFPs, Beam-like	0:17:00	"Had issues reverting to previous area with new DAQInterface version"	DAQ testing, but not listed what was tested
9941	Beam-like	8:23:00	"beam returns!"	Next run says "no beam again". I think these comments are run start and not run stop
9971	Slices, PFPs	1:13:00	"incomplete events coming from icarustpcew13 again"	
10067	Slices	0:24:00	"stopped for beam studies"	

Run 2 BNB

Cut Runs

Run	Cut	Duration		My Comments
9331	PFPs	1:00:00	"stopped to reinclude ewzom"	Did not includeTPC EWzom
9727	Events, Beam-like	0:02:00	"this run was started w.o. "wr" by mistake and immediately stopped."	
9782	Events, Beam-like	0:07:00	N/A	DAQ/Trigger tests, labeled "good for physics"
9784	Beam-like	0:13:00	N/A	DAQ/Trigger tests, labeled "good for physics"
9785	Events, PFPs, Beam-like	0:04:00	N/A	DAQ/Trigger tests, labeled "good for physics"
9842	Slices	0:10:00	"CRT replaced. back in"	Just above run there is the note "Starting from now Top CRTs with mac5 165 and 212 need to be recalibrated since the FEB were replaced."
9843	Events, Beam-like	0:08:00	N/A	Just above run is the note "DAQ new release test (thses runs should be good for physics)"
9852	Events, Beam-like	0:03:00	"DAQ quick test to test new DAQInterface version, still issues with log messages"	DAQ testing, but not listed what was tested
9853	Beam-like	0:17:00	"Had issues reverting to previous area with new DAQInterface version"	DAQ testing, but not listed what was tested
9913	Beam-like	0:29:00	"no log file start message due to misaligned DAQInterface version...times are an estimate"	Run is at the start of BNB return
10057	Beam-like	0:29:00	"beams down with no timing signals being sent"	
10060	Slices	2:43:00	"stopped for incomplete events"	